Chapter 7
Geospatial Data Issues And Standards

7-1. General

The database itself is normally the most expensive component of a GDS and represents a valuable resource to the Command. The design, development and long term maintenance of a comprehensive geospatial database is a sizable investment. Many issues must be considered to obtain maximum benefit from the database investment.

7-2. Database Development

Following a complete requirements analysis, it is possible to determine the optimum strategy for obtaining the database. Two basic methods are available - acquiring an existing government or commercial database or building a new database.

a. Acquiring an existing database. The least expensive method of obtaining a database is nearly always to acquire an existing database, if one exists that will satisfy the users' needs. Potential data sources of information of available databases include:

` Federal Geographic Data Committee (FGDC) Manual of Federal Geographic Data Products - a compendium of databases available from 21 U.S. Government agencies, including Forest Service, Bureau of the Census, Defense Mapping Agency (DMA), National Park Service, U.S. Geological Survey (USGS), Federal Highway Administration, and National Aeronautics and Space Administration (NASA).

` National Geospatial Data Clearinghouse - an electronic clearinghouse for the NSDI, under development by the FGDC.

` State Geographic Information Activities Compendium - a hardcopy summary of GIS efforts by the State governments.

` Other USACE districts - other districts may have developed a database that would satisfy users' needs.

` Local governments - county and city governments maintain geospatial databases for planning and assessments.

` Commercial sources - many commercial companies offer digital geospatial data for sale.

If an existing database can be found that meets a portion of the requirements, consideration should be given to acquire and build upon it. This technique, while not always practical, can often yield substantial savings.

b. Building a New Database. If an acceptable database is not available from any known source, it is necessary to build a new database. If possible, the cost should be shared by another organization with similar data needs. In any case, the database must be designed in detail to meet all user's needs and meet all applicable standards.

(1) Database standards. The following standards must be used in the database design:

`	Data Format	FIPSPUB 173 Spatial Data Transfer Standard
`	Metadata	FGDC Content Standard for Digital Geospatial Metadata
`	Data Collection	USACE Interim Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products
`	Data Accuracy	USACE Interim Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products
`	Data Content	Tri-Service GIS/Spatial Data Standards
`	Data Symbology	Tri-Service GIS/Spatial Data Standards

(2) Database specification. A specification serves two purposes: (1) it provides a firm set of rules for data collection and database construction, and (2) it describes the database in sufficient detail to permit application development. This document will permit use of the database inside and outside of the producing organization and result in a substantial cost savings to users. The specification may take several forms, but at a minimum should include the following sections:

` Scope - a concise abstract of the coverage of the specification.

` Applicable Documents - a bibliographic listing of the standards and references used in developing the specification.

` Database Description - a summary of the information contained in and the structure/format of the database and the intended use of the data.

` Metadata - a listing of the static metadata elements, including accuracy, datum, scale/resolution, source, and projection (if applicable).

` Data Format - a detailed description of the data format.

` Data Dictionary - a dictionary of the feature and attribute codes used in the database.

(3) Database construction. The database is built to the meet the requirements of the Database Specification. It is advisable to prototype a database and distribute the prototype to potential users, along with a copy of the draft specification, prior to finalizing the design. This procedure is easier if the database is only for internal use, but no less valuable.

7-3. Data Documentation

Consistent, complete, current documentation of geospatial data is essential to maintaining the data investment and to reduce data duplication. Geospatial data should be documented using standard metadata formats as required by ER 1110-1-8156 and described in Chapter 8 of this manual. Metadata shall be developed using the "Content Standards for Geospatial Metadata." The following are general data documentation guidelines:

` Consider the value of the data set and develop metadata accordingly. For example, do not spend $2,000 to develop a metadata file for a $100 data set and do not spend $100 on metadata for a unique, expensive, and often used data set.

` At a minimum, data providers must make metadata files at the end of a project or data collection effort. This is the most logical approach for data collection efforts that are relatively brief from start to finish. For lengthier data collection efforts and projects, data providers should consider developing metadata files at the beginning of the effort as well, to ensure optimal data sharing and partnering.

` When deciding to develop metadata files for an entire data set vs. making metadata files per coverage or themes within a data set consider cost to develop the metadata, value of the data set, frequency of use of the data set, diversity of data characteristics between themes, etc.

` Find the appropriate metadata element to record important information about a data set. For example, the Metadata Standard does not include elements that are specifically labeled, "Modeling parameters" but there are many opportunities for the modeling community to accurately describe what parameters were used to develop the data set.

7-4. Quality Assurance

a. The primary goal of data quality assurance (QA) is to ensure a consistent and measurable accuracy throughout the database. Consistency is achieved through the use of documented, approved production procedures. Following production, an assessment of the quality of the data set should be made to ensure that the expected result was achieved.

b. The level of production control and the rigor with which the assessments must be made will vary among databases, and should be consistent with the requirements for the database. For example, a cadastral database will generally have exacting accuracy requirements and equally stringent requirements for consistency. This type of database will need to have detailed procedural documentation, a completion signature for each production step, and a comprehensive assessment of accuracy - significantly increasing the cost of production. Conversely, a small-scale database intended only as a background map for geographic orientation (e.g., Digital Chart of the World from DMA) will have much less stringent production documentation requirements and only a cursory accuracy assessment. The method used to measure accuracy can have an impact on the result, so this quality assessment should be made using standard measurement techniques, such as those described in the National Map Accuracy Standard, or local techniques that are well documented.

7-5. Data Access

a. Data and metadata produced by USACE, including those produced by commercial firms under contract to USACE, shall be made available to the public to the extent permitted by law, current policies, and relevant OMB policies, including OMB Circular No. A-130, "Management of Federal Information Resources." HQUSACE, with the assistance of the GD&S Field Advisory Group, has imple

mented a procedure to provide public access to USACE geospatial metadata through the National Geospatial Data Clearinghouse. This procedure is described in ER 1110-1-8156 and in Chapter 8 of this manual.

b. Each Command is responsible for establishing procedures for responding to requests from the public for geospatial data. The mechanics of ensuring public access to data holdings should be optimized for the existing organization and unique missions of each USACE Command. Commands may choose to have all requests for geospatial managed through a single office. Others may choose to have internal divisions respond to requests for the data they collect or produce.

7-6. Data Archive

a. Geospatial data represents a significant national asset. USACE Commands shall protect against the permanent loss of data by establishing an effective data archive. The archive shall contain a copy of all data sets produced within USACE, either in-house or on contract, and have an effective cataloging system such that data sets may be retrieved in reasonable time. The data archiving process (manual, automatic, or a combination) and frequency shall be appropriate for the application and sensitivity of the data.

b. The FGDC Historical Data Working Group has developed a draft brochure that provides guidance on the responsibilities of geospatial data developers and custodians. It lists 12 circumstances under which geospatial data sets should be archived. Any geospatial database that has current or potential future value to your Command or another Government agency that cannot be easily replicated must be considered for archive. This guidance has the effect of including nearly all geospatial data.

7-7. Data Maintenance

a. Data shall be maintained as needed to support USACE applications. As a data set is updated, its metadata shall also be updated and made available to the Clearinghouse.

b. It is recommended that the update cycle be determined during the requirements analysis based on currency requirements and budgetary constraints. Data maintenance can be a costly - but necessary - on going GD&S expense. Data maintenance is a cost multiplier that must be considered as part of the overall GD&S expense.

7-8. Data Liability

Data liability is an issue that requires more attention by legal experts. Liability for the data produced by USACE can come in two forms: (1) liability for data that does not meet its stated accuracy, and (2) liability for the unintended usage of the data [Aronoff, 1989].

a. Liability for Incorrect Data. The Federal Government is protected from being sued for providing "misinformation" under the Federal Tort Claims Acts. However, the government is not protected from "malpractice." There are few precedents in this area, but the best solution for USACE Commands is to develop sound procedures for data collection, handling, and processing and to adhere to the procedures. No USACE Command shall knowingly provide data that does not meet its stated accuracy nor which has undocumented or incorrect lineage. Every effort must be made to ensure that users understand the capabilities and limits of the data set they are using.

b. Liability for misuse. In "Geographic Information Systems: A Management Perspective," Stan Aronoff provides examples of how advanced GD&S can be employed to misuse public data in a manner that would be not be possible using hardcopy. There are no standing legal precedents in this area, so a USACE-wide policy on restricting access to certain types of data cannot yet be developed. It is important that all data provided through the Clearinghouse be properly documented as to its intended use, as required by the metadata standard.

7-9. Data Policies and Coordination

a. Policies. Each USACE Command may develop tailored GD&S policies to supplement and implement this guidance document. Tailored policies regarding GD&S technologies shall be drafted by the GD&S Technical Committee and approved by the GD&S Oversight Committee. Tailored policies shall adhere to the requirements of this document and all applicable standards, orders, and OMB circulars, and they shall support the goals of the NSDI.

b. Coordination of GD&S efforts. Coordination and prioritization of geospatial data acquisition and GD&S development efforts within a USACE Command shall be the function of the GD&S Technical Committee.

c. Coordination with authorities. The GD&S Technical Committee shall appoint a representative to coordinate USACE geospatial data acquisition and GD&S development efforts with local and state governments and national GIS coordinating committees. This representative may be the Command POC or another member of the Technical Committee. If it is necessary, multiple members of this committee can liaise outside of the Command; however, information exchange then becomes critical. The purpose of

the coordination is to reduce duplicative data collection efforts and identify cost sharing opportunities.

7-10. Importance of Geospatial Data Standards

Technical progress in GD&S has resulted in wide use by many organizations of geospatial data. GD&S users need geospatial data standards to better manage this data. Users should recognize that standards are supportive of efforts to reduce redundant data, make systems more efficient and lower project costs. To this end most standards provide flexibility which allows users to adapt the standards to their specific environment. This flexibility should be used with caution, however, to avoid distortion of the standards intent.

a. Benefits of geospatial data standards. The benefits of geospatial data standards come from making the activities which the geospatial data standards support more successful. As a suite of geospatial data standards is adopted the following benefits should accrue to the activities in an organization:

` There is a removal of barriers to geospatial data exchange and a more ordered and cost-effective data sharing as standards provide exchange mechanisms for the transfer of geospatial data between dissimilar systems.

` Geospatial data quality improves and configuration management of data increases as standards provide metadata to help organize and maintain the organizations internal spatial data.

` User confidence increases that geospatial data products are as advertised and providers of data can offer a warranty for data provided as products produced to a standard give users knowledge about the structure and content of data before acquiring it.

` Standards allow increased access to geospatial data. As a result new uses are found for the data as there is an increase in the number of geospatial data product choices available to the user community.

` Integration of systems is encouraged as geospatial data can flow between them, thus maximizing effective use of systems.

` Data collection duplication is reduced and investments in those geospatial data collected provide more return on the investment in them.

` Public access to geospatial data is improved and there is an increase in the GD&S user base due to data availability with an attendant diffusion of knowledge.

b. Types of geospatial data standards. Standards may be catalogued in several ways. One is by source of authority. Standards can be de facto, such as AutoCAD DXF, where the user community, through constant use adopts a practice without any formal certification. Standards may also be certified by a government body or a professional organization. Among these are the International Standards Organization (ISO), American National Standards Institute (ANSI), National Institute of Standards and Technology (NIST), the Federal Geographic Data Committee (FGDC) and the Tri-Service CADD/GIS Technology Center or those promulgated by professional organizations such as the American Congress on Surveying and Mapping (ACSM).

Another way to catalog standards is by the functionality the standard addresses. For the GD&S area these form a framework of standards as seen below:

` Hardware and Physical Connection Standards.

These are standards that pertain to the physical connection and cabling of hardware devices.

` Application Standards.

These are standards that impact the actual presentation and display of data in a GD&S, such as map design criteria.

` Software Standards.

These are standards that address the development of software and software documentation including macros.

` Professional Standards.

These are standards that establish levels of competency and training.

` Network Communication Standards.

These are standards that address the protocols for the transfer of data and information from one computer system to another

` Data Standards.

These are standards that address geospatial data transfer formats, accuracy, documentation, structure, content and management. It is these standards which are discussed below.

7-11. Authority for Geospatial Data Standards

Standards for geospatial data in USACE are governed by the following organizations.

a. Federal Geographic Data Committee. OMB Circular A-16 (Coordination of Surveying, Mapping and Related Spatial Data Activities) establishes a process to foster the development of a national spatial data framework for an information-based society with the participation of Federal, state, and local governments, and the private sector, and to reduce duplication of effort. It addresses the responsibilities of Federal agencies in the coordination of surveying, mapping, and related spatial data. It also establishes an interagency coordinating committee known as the Federal Geographic Data Committee (FGDC). The objective of the FGDC is to promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related geospatial data.

Executive Order 12906 Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure (NSDI) states, among other things, that Federal agencies collecting or producing geospatial data shall ensure that data will be collected in a manner that meets all relevant standards adopted through the FGDC process. It also establishes the FGDC's authority over the NSDI and the National Geospatial Data Clearinghouse(Clearinghouse).

The FGDC can be contacted at:

U.S. Geological Survey
590 National Center
Reston, Virginia 22092
Telephone: (703) 648-4533
Fax: (703) 648-5755
Internet: gdc@usgs.gov

b. National Institute of Standards and Technology. The Computer Systems Laboratory at the National Institute of Standards and Technology (NIST) is responsible for developing technical, management, physical and administrative standards and guidelines for computer and related telecommunication systems. These standards are known as Federal Information Processing Standards (FIPS) Publications (FIPSPUBS). Many of these are of importance to GD&S and are discussed in the section on mandatory standards. FIPSPUBS are available from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4650

c. Tri-Service CADD/GIS Technology Center. The Tri-Service CADD/GIS Technology Center is a multi-service vehicle to set standards and coordinate facilities CADD and GIS within the Department of Defense. It also promotes system integration and standards including naming conventions, common GIS layers, standard symbology, databases and analysis tools. The Tri-Service Center can be reached at:

Tri-Service CADD/GIS Technology Center
Information Technology Laboratory
(CEWES-ID-C)
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199
Telephone: (601) 634-4582
Fax: (601) 634-4584
Internet: wesimda@ex1.wes.army.mil

7-12. Applicable Standards

Some standards are going to impact all USACE organizations. Others will only be of concern to USACE organizations with special circumstances. Mandatory standards are those that are sufficiently mature that all USACE components must follow them. ER 1110-1-8156, paragraph 6 requires that anyone who believes these standards are inappropriate for their use must apply to CECW-EP-S for a waiver. The waiver must explain why the standards are inappropriate and what will be used instead. Recommended standards are those where compliance is encouraged but the maturity of the standard is not sufficient for them to be mandatory.

a. Mandatory geospatial data standards.

(1) Federal Information Processing Standards Publications.

Use of Federal Information Processing Standards (FIPS) are mandatory for USACE GD&S. The USGS Open-file Report 88-105, *A Process for Evaluating GIS*, provides a 63 page annotated list of Federal Information Processing Standards (FIPS) and National Bureau of Standards GD&S related standards, guidelines and references. The report can be acquired from:

USGS Earth Science Information Center
507 National Center
Reston, VA 22092
Toll Free Number: 1-800-USA-MAPS
Telephone: (703) 648-5920
FAX: (703) 648-5548

The FIPS Publications are available from:

National Technical Information Service
Computer Products Office
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4600

(2) FIPS 173 Spatial Data Transfer Standard.

The Spatial Data Transfer Standard (SDTS) provides specifications for the organization and structure of digital spatial data transfer, definition of spatial features and attributes, and data transfer encoding. The purpose of the standard is to promote and facilitate the transfer of digital spatial data between dissimilar computer systems. This standard is for use in the acquisition and development of government applications and programs involving the transfer of digital spatial data between dissimilar computer systems. The use applies when the transfer of digital spatial data occurs or is likely to occur within and/or outside of the Federal Government. It is likely that vendors/producers of leading GD&S will introduce SDTS import/export capability in the future. The SDTS is a key element of the NSDI and is the result of FGDC efforts.

(3) Content Standards for Digital Geospatial Metadata.

This standard specifies the information content of metadata for a set of digital geospatial data. The purpose of the standard is to provide a common set of terminology and definitions for concepts related to these metadata. This standard is the data documentation standard referenced in Executive Order 12906 which mandates the documentation of all new geospatial data starting 11 January 1995 and the development of a plan to document geospatial data previously collected or produced, by 11 April 1995.

The metadata standard is the product of the FGDC. Executive Order 12906 instructs Federal agencies to use the metadata standard to document new geospatial data beginning in 1995 and to provide these metadata to the public through the National Geospatial Data Clearinghouse. The GD&S vendor community may provide metadata software in the future. Several pieces of public domain metadata software are available. Document.aml is a public domain metadata macro for use with ARC/INFO. CORPSMET is a DOS-based public domain metadata software developed by USACE. CORPSMET can be used to document any geospatial data independently of the geospatial data system in use.

(4) USACE Interim Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products.

This is to be used for prescribing standards and specifications for USACE field surveys, maps, engineering drawings, and related spatial data products. It is applicable to all HQUSACE elements, major subordinate commands, districts, laboratories, and field operating activities having civil works, military programs, and environmental restoration responsibilities. It also applies to functional areas having responsibilities for regulatory investigations and studies, real estate, and support to Army installation master planning, and other functions involving surveying, mapping, or spatial database development.

(5) Tri-Service GIS/Spatial Data Standards (TSSDS).

These standards are applicable to all Department of Defense activities having civil works or public works, military programs, and environmental programs or that are responsible for facilities/installation management. They prescribe standards and specifications for GIS and related spatial data. The intent is to create standards that will satisfy the project life-cycle concept for digital data. The TSSDS are intended to contain requirements for standard data entry, storage and retrieval, using predefined screen displays and plotting routines. There are many subcommittees and working groups of the FGDC that are development of content standards and the work is at various levels of maturity. The final versions of these standards will be incorporated into the TSSDS for distribution and use throughout USACE therefore by using the most recent version of the TSSDS one will also be using the most recent FGDC content standards. The proponent for this standard is the Tri-Service CADD/GIS Technology Center.

b. Military standards. Those elements of USACE working with Defense Mapping Agency (DMA) geospatial data may find it necessary to use Military Standards (MIL-STD). As of 27 December 1994 DoD agencies may not require vendors to support Military Standards unless the agency obtains a waiver to do so. USACE employees should check with Procurement or Engineering Chiefs for the most current guidance related to this requirement. The DMA standards and specifications program is described in Digitizing the Future. It is available from the DMA Headquarters Plans and Requirements Directorate in care of:

Director, Defense Mapping Agency
ATTN: PR (MS A-13)
8613 Lee Highway
Fairfax, Virginia 22031-2137
Telephone: (703) 285-9339 or 9333

c. Recommended geospatial data standards. These are standards that are in various stages of development and which may become USACE standards in the future.

(1) Open Geodata Interoperability Standard/ Specification (OGIS).

The OGIS is a public domain software specification designed to promote true interchange among varied software and data structures. The OGIS is motivated by the costs of data conversion and sees independence from proprietary data structures. The OGIS project delivered a draft standards specification document in February 1994.

The proponent of the OGIS is the Open GIS Foundation (OGF) which may be reached at:

1 Kendall Square
Building 200, Suite 2200
Cambridge, MA 02139
Telephone: (617) 621-7025
FAX: (617) 621-7174

d. Guidelines.

(1) Guidelines for Implementing the National Geospatial Data Clearinghouse.

As defined in Executive Order 12906 the National Geospatial Data Clearinghouse is “a distributed network of geospatial data producers, managers and users linked electronically.” Initially the clearinghouse functions are to publicize what geospatial data exists, the condition of these data and instructions on accessing the data. Later functions will provide direct access to the data, allow producers to publicize data that are prepared and planned and let users advertise their data needs. The clearinghouse will build on the Metadata Standard and the SDTS and will exploit the Wide Area Information Servers (WAIS).

The FGDC Clearinghouse Working Group developed the Clearinghouse and conducted a prototype test in the Fall of 1993. The EO 12906 requires the FGDC to establish a Clearinghouse within six months of the date of the order. The Clearinghouse is established and the Working Group is pursuing development of user guides, software enhancements and related support materials.